

SECTION 03930
CONCRETE REHABILITATION

PART 1 - GENERAL

0.1 DESCRIPTION OF WORK

- A.** Work Included: This Section specifies the following items.
1. Removal of deteriorated concrete and reinforcement and subsequent replacement and patching.
 2. Floor joint repair.
 3. Epoxy crack injection.
- B.** Related Work: The following items are not included in this Section and will be performed under the designated Sections:
1. Section 07190 - WATER REPELLENTS; clear penetrating and film-forming water repellents applied to concrete.
 2. Section 03300 - CAST-IN-PLACE CONCRETE
 3. Section 03371 - SHOTCRETE

0.2 SUBMITTALS

- A.** Product Data: For each type of product indicated. Include material descriptions, chemical composition, physical properties, test data, and mixing, preparation, and application instructions.
- B.** Formwork and Shoring Drawings: Prepared by or under the supervision of a qualified professional engineer detailing formwork and temporary shoring and supports. Include schedule and sequence for erection and removal relative to removal of deteriorated concrete and reinforcement and subsequent repair and reinforcement.
- C.** Samples: Cured Samples of patching materials.
- D.** Qualification Data: For installers.
- E.** Material Certificates: For each type of product indicated, signed by manufacturers.
- F.** Rehabilitation Program: For each phase of rehabilitation process, including protection of surrounding materials and Project site during

operations. Describe in detail materials, methods, equipment, and sequence of operations to be used for each phase of the Work.

1. If alternative materials and methods to those indicated are proposed for any phase of rehabilitation work, submit substitution request and provide a written description of proposed materials and methods, including evidence of successful use on other comparable projects, and a testing program to demonstrate their effectiveness for this Project.

0.3 QUALITY ASSURANCE

- A. Installer Qualifications: Installer that employs workers trained and approved by manufacturer.
- B. Manufacturer Qualifications: Manufacturer that employs factory-trained representatives who are available for consultation and Project-site inspection.
- C. Source Limitations: Obtain each type of material through one source from a single manufacturer.
- D. Hold Point - Mockups: Build mockups for concrete removal and patching, floor joint repair and epoxy crack injection to demonstrate aesthetic effects and set quality standards for materials and execution.
 1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

0.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in manufacturer's original and unopened containers, labeled with type and name of products and manufacturers.
- B. Comply with manufacturer's written instructions for minimum and maximum temperature requirements and other conditions for storage.
- C. Store cementitious materials off the ground, under cover, and in a dry location.
- D. Store aggregates, covered and in a dry location, where grading and other required characteristics can be maintained and contamination avoided.

0.5 PROJECT CONDITIONS

- A. Environmental Limitations for Epoxies: Do not apply when air and substrate temperatures are outside limits permitted by manufacturer. During hot weather, cool epoxy components before mixing, store mixed

products in shade, and cool unused mixed products to retard setting. Do not apply to wet substrates unless approved by manufacturer.

1. Use only Class A epoxies when substrate temperatures are below or are expected to go below 40deg F within 8 hours.
2. Use only Class A or B epoxies when substrate temperatures are below or are expected to go below 60 deg F within 8 hours.
3. Use only Class C epoxies when substrate temperatures are above and are expected to stay above 60 deg F for 8 hours.

B. Cold-Weather Requirements for Cementitious Materials: Comply with the following procedures:

1. When air temperature is below 40 deg F, heat patching material ingredients and existing concrete to produce temperatures between 40 and 90 deg F.
2. When mean daily air temperature is between 25 and 40 deg F, cover completed Work with weather-resistant insulating blankets for 48 hours after repair or provide enclosure and heat to maintain temperatures above 32 deg F within the enclosure for 48 hours after repair.
3. When mean daily air temperature is below 25 deg F, provide enclosure and heat to maintain temperatures above 32 deg F within the enclosure for 48 hours after repair.

C. Hot-Weather Requirements for Cementitious Materials: Protect repair work when temperature and humidity conditions produce excessive evaporation of water from patching materials. Provide artificial shade and wind breaks, and use cooled materials as required. Do not apply to substrates with temperatures of 90 deg F and above.

PART 2 - PRODUCTS

0.1 BONDING AGENTS

A. Epoxy-Modified, Cementitious Bonding and Anticorrosion Agent: Product that consists of water-insensitive epoxy adhesive, Portland Cement, and water-based solution of corrosion-inhibiting chemicals that forms a protective film on steel reinforcement.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Euclid Chemical Company (The); Corr-Bond.
 - b. Sika Corporation; Armatec 110 EpoCem.
 - c. Sonneborn, Div. of ChemRex; Sonoprep.
 - d. Tamms Industries, Inc.; Duralprep A.C.

B. Epoxy Bonding Agent: ASTM C 881/C 881M, Type II.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Anti-Hydro International, Inc.; Poly-Epoxy Bonding #100.
 - b. Euclid Chemical Company (The); Euco #452 Epoxy System.
 - c. Sika Corporation; Sikadur 35, Hi-Mod LV.
 - d. Sonneborn, Div. of ChemRex; Epogel or Epogrip.
 - e. Tamms Industries, Inc.; Duralbond.
 - f. ThoRoc, Div. of ChemRex; Epoxy Adhesive 24LPL.

C. Mortar Scrub-Coat: 1 part Portland Cement complying with ASTM C 150, Type I, II, or III and 1 part fine aggregate complying with ASTM C 144, except 100 percent passing a No. 16 sieve.

0.2 PATCHING MORTAR

A. Patching Mortar, General:

1. Unless otherwise indicated, use any of the products specified in this Article.
2. Overhead Patching Mortar: For overhead repairs, use patching mortar recommended by manufacturer for overhead use and as specified in this Article.
3. Coarse Aggregate for Adding to Patching Mortar: Washed aggregate complying with ASTM C 33, Size No. 8, Class 5S. Add only as permitted by patching mortar manufacturer.

B. Cementitious Patching Mortar: Packaged, dry mix complying with ASTM C 928.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cementitious Patching Mortar:
 - 1) Sika Corporation; Sikarepair 223.
 - 2) Sonneborn, Div. of ChemRex; Deep Pour Mortar.
 - 3) ThoRoc, Div. of ChemRex; LA Repair Mortar.
 - b. Cementitious Patching Mortar, Rapid Setting:
 - 1) Meadows, W. R. Inc.; Sealtight Meadow-Patch 20.
 - 2) Sika Corporation; Sikaset Roadway Patch.
 - 3) Sonneborn, Div. of ChemRex; Road Patch.
 - 4) Tamms Industries, Inc.; Speed Crete 2028.
 - 5) ThoRoc, Div. of ChemRex; 10-61 Rapid Mortar.

0.3 CONCRETE

- A.** Concrete Materials and Admixtures: Comply with Division 3 Section 03300 "Cast-in-Place Concrete".
- B.** Steel and Fiber Reinforcement and Reinforcement Accessories: Comply with Division 3 Section 03300 "Cast-in-Place Concrete".
- C.** Form-Facing Materials: Comply with Division 3 Section 03300 "Cast-in-Place Concrete".
- D.** Shotcrete: Comply with Division 3 Section 03371 "Shotcrete".
- E.** Preplaced Aggregate: Washed aggregate complying with ASTM C 33, Class 5S, with 100 percent passing a 1-1/2-inch sieve, 95 to 100 percent passing a 1-inch sieve, 40 to 80 percent passing a 3/4-inch sieve, 0 to 15 percent passing a 1/2-inch sieve, and 0 to 2 percent passing a 3/8-inch sieve.
- F.** Fine Aggregate for Grout Used with Preplaced Aggregate: Fine aggregate complying with ASTM C 33, but with 100 percent passing a No. 8 sieve, 95 to 100 percent passing a No. 16 sieve, 55 to 80 percent passing a No. 30 sieve, 30 to 55 percent passing a No. 50 sieve, 10 to 30 percent passing a No. 100 sieve, 0 to 10 percent passing a No. 200 sieve, and having a fineness modulus of 1.30 to 2.10.
- G.** Grout Fluidifier for Grout Used with Preplaced Aggregate: ASTM C 937.
- H.** Portland Cement for Grout Used with Preplaced Aggregate: ASTM C 150.
- I.** Pozzolans for Grout Used with Preplaced Aggregate: ASTM C 618.

0.4 MISCELLANEOUS MATERIALS

- A.** Epoxy Joint Filler: 2-component, semirigid, 100 percent solids, epoxy resin with a Type A Shore durometer hardness of at least 80 per ASTM D 2240.
- B.** Epoxy Crack Injection Adhesive: ASTM C 881/C 881M.
- C.** Capping Adhesive: Product manufactured for use with crack injection adhesive by same manufacturer.
- D.** Corrosion-Inhibiting Treatment Materials: Water-based solution of alkaline corrosion-inhibiting chemicals that penetrates concrete by diffusion and forms a protective film on steel reinforcement.
- E.** Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
 - 1. After fabricating, prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning".

2. After preparation, apply two-coat high-performance coating system consisting of organic zinc-rich primer, complying with SSPC-Paint 20 or SSPC-Paint 29 and topcoat of high-build, urethane or epoxy coating recommended by manufacturer for application over specified zinc-rich primer. Comply with coating manufacturer's written directions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel", for shop painting.
- F.** Bolts, Nuts, and Washers: Carbon steel; ASTM A 307, Grade A, for bolts; ASTM A 563, Grade A, for nuts; and ASTM F 436 for washers; hot-dip or mechanically zinc coated.
- G.** Postinstalled Anchors: Chemical or expansion anchors, made from stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 for bolts and nuts; ASTM A 666 or ASTM A 276, Type 304 or 316, for anchors, with capability to sustain, without failure, a load equal to four times the load imposed, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

0.5 MIXES

- A.** Mix products, in clean containers, according to manufacturer's written instructions.
1. Add clean silica sand and coarse aggregates to products only as recommended by manufacturer.
 2. Do not add water, thinners, or additives unless recommended by manufacturer.
 3. When practical, use manufacturer's premeasured packages to ensure that materials are mixed in proper proportions. When premeasured packages are not used, measure ingredients using graduated measuring containers; do not estimate quantities or use shovel or trowel as unit of measure. Only use full, unopened bags.
 4. Do not mix more materials than can be used within recommended open time. Discard materials that have begun to set.
- B.** Mortar Scrub-Coat: Mix with enough water to provide consistency of thick cream.
- C.** Dry-Pack Mortar: Mix with just enough liquid to form damp cohesive mixture that can be squeezed by hand into a ball but is not plastic.
- D.** Concrete: Comply with Division 3 Section 03300 "Cast-in-Place Concrete".
- E.** Shotcrete: Comply with Division 3 Section 03371 "Shotcrete".
- F.** Grout for Use with Preplaced Aggregate: Proportion according to ASTM C 938. Add grout fluidifier to mixing water followed by cementitious materials and then fine aggregate.

PART 3 - EXECUTION

0.1 EXAMINATION

- A.** Notify Engineer seven days in advance of dates when areas of deteriorated or delaminated concrete and deteriorated reinforcing bars will be located.
- B.** Locate areas of deteriorated or delaminated concrete using hammer or chain drag sounding and mark boundaries. Mark areas for removal by simplifying and squaring off boundaries as directed by Engineer. At columns and walls make boundaries level and plumb, unless otherwise indicated.
- C.** Locate at least three reinforcing bars using a pachometer, and drill test holes to determine depth of cover. Calibrate pachometer, using depth of cover measurements, and verify depth of cover in removal areas using pachometer.

0.2 PREPARATION

- A.** Protect people, motor vehicles, equipment, surrounding construction, Project site, plants, and surrounding buildings from injury resulting from concrete rehabilitation work.
 - 1. Erect and maintain temporary protective covers over pedestrian walkways and at points of entrance and exit for people and vehicles, unless such areas are made inaccessible during the course of concrete rehabilitation work. Construct covers of tightly fitted, 3/4-inch exterior-grade plywood supported at 16 inches o.c. and covered with asphalt roll roofing.
 - 2. Protect adjacent equipment and surfaces by covering them with heavy polyethylene film and waterproof masking tape or a liquid strippable masking agent. If practical, remove items, store, and reinstall after potentially damaging operations are complete.
 - 3. Neutralize and collect alkaline and acid wastes according to requirements of authorities having jurisdiction, and dispose of by legal means off Authority's property.
 - 4. Dispose of runoff from wet operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.
- B.** Shoring: Install temporary supports before beginning concrete removal.
- C.** Concrete Removal:
 - 1. Saw-cut perimeter of areas indicated for removal to a depth of at least 1/2 inch. Make cuts perpendicular to concrete surfaces and no deeper than cover on reinforcement.

2. Remove deteriorated and delaminated concrete by breaking up and dislodging from reinforcement.
3. Remove additional concrete, if necessary, to provide a depth of removal of at least 1/2 inch over entire removal area.
4. Where half or more of the perimeter of reinforcing bar is exposed, bond between reinforcing bar and surrounding concrete is broken, or reinforcing bar is corroded, remove concrete from entire perimeter of bar and to provide at least a 3/4-inch clearance around bar.
5. Test areas where concrete has been removed by tapping with hammer, and remove additional concrete until unsound and disbonded concrete is completely removed.
6. Provide fractured aggregate surfaces with a profile of at least 1/8 inch that is approximately perpendicular or parallel to original concrete surfaces. At columns and walls, make top and bottom surfaces level, unless otherwise directed.
7. Thoroughly clean removal areas of loose concrete, dust, and debris.

D. Reinforcing Bar Preparation: Remove loose and flaking rust from reinforcing bars by abrasive blast cleaning until only tightly bonded light rust remains.

1. Where section loss of reinforcing bar is more than 25 percent, or 20 percent in 2 or more adjacent bars, cut bars and remove and replace as directed by Engineer. Remove additional concrete as necessary to provide at least 3/4-inch clearance at existing and replacement bars. Splice replacement bars to existing bars according to ACI 318, by lapping, welding, or using mechanical couplings.

E. Preparation of Floor Joints for Repair: Saw-cut joints full width to edges and depth of spalls, but not less than 3/4 inch deep. Clean out debris and loose concrete; vacuum or blow clear with compressed air.

F. Surface Preparation for Corrosion-Inhibiting Treatment: Clean concrete by low-pressure water cleaning, detergent scrubbing or sand blasting to remove dirt, oils, films, and other materials detrimental to treatment application. Allow surface to dry before applying corrosion-inhibiting treatment.

0.3 APPLICATION

A. General: Comply with manufacturer's written instructions and recommendations for application of products, including surface preparation.

B. Epoxy-Modified, Cementitious Bonding and Anticorrosion Agent: Apply to reinforcing bars and concrete by stiff brush or hopper spray according to manufacturer's written instructions. Apply to reinforcing bars in two coats, allowing first coat to dry two to three hours before applying second coat. Allow to dry before placing patching mortar or concrete.

- C.** Epoxy Bonding Agent: Apply to reinforcing bars and concrete by brush, roller, or spray according to manufacturer's written instructions, leaving no pinholes or other uncoated areas. Apply to reinforcing bars in at least two coats, allowing first coat to dry before applying second coat. Apply patching mortar or concrete while epoxy is still tacky. If epoxy dries, recoat before placing patching mortar or concrete.
- D.** Latex Bonding Agent, Type II: Mix with Portland Cement and scrub into concrete surface according to manufacturer's written instructions. Apply patching mortar or concrete while bonding agent is still wet. If bonding agent dries, recoat before placing patching mortar or concrete.
- E.** Latex Bonding Agent, Type I: Apply to concrete by brush roller or spray. Allow to dry before placing patching mortar or concrete.
- F.** Mortar Scrub-Coat: Dampen repair area and surrounding concrete 6 inches beyond repair area. Remove standing water and apply scrub-coat with a brush, scrubbing it into surface and thoroughly coating repair area. If scrub-coat dries, recoat before applying patching mortar or concrete.
- G.** Patching Mortar: Unless otherwise recommended by manufacturer, apply as follows:
1. Wet substrate thoroughly and then remove standing water. Scrub a slurry of neat patching mortar mixed with latex bonding agent into substrate, filling pores and voids.
 2. Place patching mortar by troweling toward edges of patch to force intimate contact with edge surfaces. For large patches, fill edges first and then work toward center, always troweling toward edges of patch. At fully exposed reinforcing bars, force patching mortar to fill space behind bars by compacting with trowel from sides of bars.
 3. For vertical patching, place material in lifts of not more than 2 inches nor less than 1/4 inch. Do not feather edge.
 4. For overhead patching, place material in lifts of not more than 1-1/2 inches nor less than 1/8 inch. Do not feather edge.
 5. After each lift is placed, consolidate material and screed surface.
 6. Where multiple lifts are used, score surface of lifts to provide a rough surface for application of subsequent lifts. Allow each lift to reach final set before placing subsequent lifts.
 7. Allow surfaces of lifts that are to remain exposed to become firm and then finish to a smooth surface with a broom or burlap drag.
 8. Wet-cure cementitious patching materials, including polymer-modified, cementitious patching materials, for not less than seven days by water-fog spray or water-saturated absorptive cover.
- H.** Dry-Pack Mortar: Use for deep cavities and where indicated. Unless otherwise recommended by manufacturer, apply as follows:
1. Provide forms where necessary to confine patch to required shape.
 2. Wet substrate and forms thoroughly and then remove standing water.

3. Place dry-pack mortar into cavity by hand, and compact into place with a hardwood drive stick and mallet or hammer. Do not place more material at a time than can be properly compacted. Continue placing and compacting until patch is approximately level with surrounding surface.
 4. After cavity is filled and patch is compacted, trowel surface to match profile and finish of surrounding concrete. A thin coat of patching mortar may be troweled into the surface of patch to help obtain required finish.
 5. Wet-cure patch for not less than seven days by water-fog spray or water-saturated absorptive cover.
- I. Concrete:** Place according to Division 3 Section 03300 "Cast-in-Place Concrete" and as follows:
1. Apply bonding agent to reinforcement and concrete substrate.
 2. Use vibrators to consolidate concrete as it is placed.
 3. At unformed surfaces, screed concrete to produce a surface that when finished with patching mortar will match required profile and surrounding concrete.
 4. Where indicated place concrete by form and pump method.
 - a. Design and construct forms to resist pumping pressure in addition to weight of wet concrete. Seal joints and seams in forms and junctions of forms with existing concrete.
 - b. Pump concrete into place, releasing air from forms as concrete is introduced. When formed space is full, close air vents and pressurize to 14 psi.
 5. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.
 6. Fill placement cavities with dry-pack mortar and repair voids with patching mortar. Finish to match surrounding concrete.
- J. Shotcrete:** Place according to Division 3 Section 03371 "Shotcrete" and as follows:
1. Apply bonding agent to reinforcement and concrete substrate.
 2. Screed and finish shotcrete to produce a surface matching required profile and surrounding concrete.
- K. Grouted Preplaced Aggregate Concrete:** Use for column and wall repairs. Place as follows:
1. Design and construct forms to resist pumping pressure in addition to weight of wet grout. Seal joints and seams in forms and junctions of forms with existing concrete.
 2. Apply bonding agent to reinforcement and concrete substrate.

3. Place aggregate in forms, consolidating aggregate as it is placed. Pack aggregate into upper areas of forms to achieve intimate contact with concrete surfaces.
4. Fill forms with water to thoroughly dampen aggregate and substrates. Drain water from forms before placing grout.
5. Pump grout into place at bottom of preplaced aggregate, forcing grout upward. Release air from forms at top as grout is introduced. When formed space is full and grout flows from air vents, close vents and pressurize to 14 psi.
6. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.
7. Repair voids with patching mortar and finish to match surrounding concrete.

L. Joint Filler: Install in nonmoving floor joints where indicated.

1. Install filler to a depth of at least 2 inches. Use fine silica sand no more than 1/4 inch deep to close base of joint. Do not use sealant backer rods or compressible fillers below joint filler.
2. Install filler so that when cured, it is flush at top surface of adjacent concrete. If necessary, overfill joint and remove excess when filler has cured.

M. Epoxy Crack Injection: Comply with manufacturer's written instructions and the following:

1. Clean areas to receive capping adhesive of oil, dirt, and other substances that would interfere with bond, and clean cracks with oil-free compressed air or low-pressure water to remove loose particles.
2. Place injection ports as recommended by epoxy manufacturer, spacing no farther apart than thickness of member being injected. Seal injection ports in place with capping adhesive.
3. Seal cracks at exposed surfaces with a ribbon of capping adhesive at least 1/4 inch thick by 1 inch wider than crack.
4. Inject cracks wider than 0.003 inch to a depth of 8 inches or to a width of less than 0.003 inch, whichever is less.
5. Inject epoxy adhesive, beginning at widest part of crack and working toward narrower parts. Inject adhesive into ports to refusal, capping adjacent ports when they extrude epoxy. Cap injected ports and inject through adjacent ports until crack is filled.
6. After epoxy adhesive has set, remove injection ports and grind surfaces smooth.

N. Corrosion-Inhibiting Treatment: Apply by brush, roller, or airless spray in two coats at manufacturer's recommended application rate. Remove film of excess treatment by high-pressure washing before patching treated concrete.

0.4 FIELD QUALITY CONTROL

- A.** Testing Agency: Contractor shall engage a qualified testing agency to sample materials and perform tests as follows:
1. Patching Mortar, Packaged Mixes: Randomly selected samples tested according to ASTM C 928.
 2. Concrete: As specified in Division 3 Section "Cast-in-Place Concrete".
 3. Shotcrete: As specified in Division 3 Section "Shotcrete".
 4. Grouted Preplaced Aggregate: Tested for compressive strength of grout according to ASTM C 942.
 - a. Testing Frequency: One sample for each 25 cu. yd. of grout or fraction thereof, but not less than one sample for each day's work.
 5. Joint Filler: Core drilled samples to verify proper installation.
 - a. Testing Frequency: One sample for each 100 feet of joint filled.
 - b. Where samples are taken, fill holes with joint filler.
 6. Epoxy Crack Injection: Core drilled samples to verify proper installation.
 - a. Testing Frequency: 3 samples from mockup and 1 sample for each 100 feet of crack injected.
 - b. Where samples are taken, fill holes with epoxy mortar.

PART 4 - MEASUREMENT AND PAYMENT

0.1 MEASUREMENT

- A.** Concrete rehabilitation will be measured as per square foot complete in place, including all preparation, accessories and incidentals.

0.2 PAYMENT

- A.** Payment for concrete rehabilitation will be made at the Contract unit price for the quantities as specified above.
- B.** Unit prices include the cost of preparing existing construction to receive the work indicated and costs of field quality control testing required by the Work for which the unit price applies.
- C.** Concrete Removal and Replacement or Patching: Work will be paid for by the cubic foot computed on the basis of rectangular solid shapes

approximating the actual shape of concrete removed and replaced with average depths, widths, and lengths, measured to the nearest inch.

1. Reinforcing bar replacement will be paid for separately by the pound of replacement steel with welded and mechanical splices paid for by the unit.

- B.** Epoxy Crack Injection: Work will be paid for by the linear foot of crack injected.

0.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0310.049	CONCRETE CLEANING AND RESTORATION	SF

END OF SECTION

NOTES TO THE DESIGNER

- A.** Any request to modify or waive the specification requirements listed below must be approved in writing by the MBTA's Director of Design:

1. None.